Association between asthma and physical activity in Korean adolescents: the 3rd Korea Youth Risk Behavior Web-based Survey (KYRBWS-III)

Jae-Woo Kim1*, Wi-Young So2*, Yeon Soo Kim3

1 Department of Physical Education, Korea Military Academy, Seoul, Korea
2 Department of Human Movement Science, Seoul Women’s University, Seoul, Korea
3 Department of Physical Education, Seoul National University, Seoul, Korea

*These authors contributed equally to this work.

Correspondence: Yeon Soo Kim, Department of Physical Education, College of Education, Seoul National University, 599 Gwanangno, Gwanak-Gu, Seoul 151-742, Korea, tel: +82-2-880-7804, fax: +82-2-880-7806, e-mail: kys0101@snu.ac.kr

Background: Asthma is the leading chronic illness among children and adolescents in several nations. This study investigated the association between asthma and physical activity (PA). Methods: The findings in this study are based on the data obtained from the 2007 3rd Korea Youth Risk Behavior Web-based Survey (KYRBWS-III), a cross-sectional survey of health-risk behaviours among a representative sample of Korean middle- and high-school students aged 13–18 years. This survey is conducted annually by the Korea Centers for Disease Control and Prevention. The 72,943 study subjects were selected using the complex sampling design of the survey. The association between asthma and PA was assessed by conducting multiple logistic regression analyses of the data by using the statistical software SPSS 17.0 Complex Sample. Results: Compared with the adolescents without current asthma, significantly fewer adolescents with current asthma had a sedentary time of 3 h or less per day (odds ratio, 0.86; 95% confidence interval, 0.75–0.97). Sedentary time was defined as time spent watching television, surfing the Internet, or playing computer games and excluded the time spent doing homework or study during leisure time. The analysis was adjusted for age, gender, family affluence level (FAL), obesity, allergic rhinitis, atopy and smoking. With regard to participation in adequate vigorous or moderate PA, strengthening exercise or physical education class, no significant differences were found between the adolescent students with current asthma and those without current asthma. In addition, it was found that all PA had no significant differences in their effects on asthma severity (medication, inability to work and absence from school). Conclusion: Our results show that the amount of sedentary time influenced asthma prevalence; however, PA did not influence asthma prevalence in Korean adolescents.

Introduction

Asthma prevalence has increased over several decades.1–4 Epidemiological investigations have consistently identified age, parental history of asthma or allergies at particular stages of childhood development, atopy, house-dust mite or cockroach sensitisation and exposure, and lower socioeconomic status (SES) as risk factors for asthma in children.5,6 Although, many of these risk factors are often difficult, if not impossible, to modify, several health behaviours that can cause or exacerbate asthma, such as smoking, physical activity (PA) and obesity can be modified. The reasons for the increase in the prevalence of asthma observed in most countries are not known, but frequent lifestyle changes has been reported to possibly contribute to this increase.7 In some countries, the increase in asthma prevalence in children has been associated with a similar increase in the prevalence of obesity, decreased PA and increased sedentary time.7–11 In the USA, the prevalence of self-reported asthma among children increased to 75% during the period 1980–1999.12 During the same period, the body mass index (BMI) of children and adolescents in the USA showed an increase,13 indicating decreased PA and thus increased sedentary time.13 Accordingly, asthma, obesity and PA or sedentary time are strongly interrelated, but there are good arguments for the primary role of obesity, changes in diet or decreased PA in the increase in asthma prevalence.

Many studies have examined the relationship between asthma and obesity, and the findings of most of these previous studies suggest that obesity, particularly BMI, is related to asthma or wheezing.10,11,14 Furthermore, some studies reported an association between PA or sedentary time and asthma, but their results are controversial because some showed a significant association,15–19 whereas others did not.20–22 Accordingly, the potential role of PA or sedentary time in preventing asthma is still unknown.23

In fact, the risk for asthma between Finnish adult twins15 decreased more with increased PA than with decreased sedentary time, and children who engaged in fewer PAs were more likely to develop asthma later in their childhood (mean age: initial, 3.5 years; follow-up, 11.5 years).17 In contrast, in a prospective study of older women, regular PA was found to be associated with asthma exacerbation,18 and in another study in children, asthma was positively correlated with fitness and the time spent in vigorous activity.15 Furthermore, Beckett et al.20 reported that asthma is associated with weight gain, independent of PA, in women but not in men. Huovinen et al.21 reported that individuals with asthma seem to be as physically active as those without asthma, as implied by the energy expenditure during leisure activities measured by the Canadian Population Health Survey (1994–1995).

Thus, an investigation of the association between asthma and PA is valuable in the following aspects: (i) regular PA has health benefits in that it reduces the risk of mortality, chronic diseases and some cancers. (ii) obesity may be closely linked to other factors such as PA or sedentary time, which might partly explain the association between obesity and asthma. (iii) PA does not increase inflammation in children with allergic asthma24 and in young children with increased bronchial responsiveness.25

Therefore, the purpose of this study was to investigate the cross-sectional association between regular PA and asthma in adolescents based on the data from the 3rd Korea Youth Risk Behavior Web-Based Survey (KYRBWS-III).
Methods

In this study, we used the data from the KYRBWS-III to evaluate the relationship between self-reported asthma and PA in adolescents, taking into account potential confounding factors.

The KYRBWS-III is an anonymous, internet-based, self-administered structured questionnaire intended to investigate health-risk behaviours and has been conducted by the Korea Centers for Disease and Prevention. The KYRBWS-III was administered to a nationally representative sample of middle- and high-school students, using a complex sampling design involving stratification, clustering and multistage sampling. A representative sample of students from the 7–12th grade, aged 13–18 years, was selected; this sample consisted of 78,834 students from 24,000 classrooms (secondary sampling units) in 800 middle and high schools (primary sampling units) and from 192 strata identified using the stratified multistage cluster sampling method.26

After sample determination, the students were assigned unique identification numbers by classroom teachers. The students accessed the survey Web page by using their ID numbers and responded to a question about their willingness to participate. Willing participants self-administered the questionnaire anonymously at the school, and those unwilling did not proceed further. As the KYRBWS-III did not collect private information, ethical approval was not required.

Questionnaire and definition of variables

Asthma

Self-reported current asthma was evaluated using the following two questions: 'Did a doctor ever say that you had asthma?' and 'Do you still have asthma?' Current asthma was defined as a yes response to both questions. Those who answered yes to the first question and no to the second question or no to the first question were considered not to have current asthma. To assess asthma severity, the students with current asthma were asked three questions. In the item 'take medication for asthma', the respondents were asked whether they had taken a prescription for asthma medication to manage asthma symptoms during the past 12 months. The response options ranged from 'always', 'only with symptoms', or 'never'. Under the item 'unable to work because of asthma', the respondents indicated whether they had been unable to perform their usual activities or study because of their asthma. 'Absence from school owing to asthma' provided information about the number of days the students were absent from school because of asthma during the past 12 months with the response options 'never', '1–3 days', '4–6 days' and '7 days'.

Physical activity

The questionnaire items for PA consisted of five questions on vigorous PA, moderate PA, strengthening exercise, sedentary time and attending physical education classes in school.

Vigorous PA involved PA such as heavy lifting, digging or aerobics; moderate PA, carrying light loads or doubles tennis; and strengthening exercise, push-ups or weight lifting. Those who responded to the question were asked about the number of days they performed each PA during the past week, ranging from 'never' to '5 days or more per week'. These variables were then classified as vigorous PA (<3 days per week or ≥3 days per week), moderate PA (<5 days per week or ≥5 days per week) or strengthening exercise (<3 days per week or ≥3 days per week).

The respondents to the question on sedentary time indicated the number of hours they spent performing sedentary activities including watching television, playing online games or surfing the Internet and excluding time spent studying or doing homework in leisure time during the past week. The responses ranged from '<1 h per day' to '≥4 h per day'. These variables were then classified as sedentary time <3 h per day or ≥3h per day.

The respondents to the item 'attending physical education classes in school' indicated the number of hours they attended physical education classes held at the playground or at the gym during the week before the survey. The responses ranged from 'never' to '≥3 h per week'. These were classified as <1 h per week or ≥1 h per week of time spent in attending physical education.

Obesity

Obesity was based on self-reported weight and height in standing position, and the BMI (kg/m²) was calculated using each participant’s height and weight. BMI is independent of stature and correlates well with the relative size of body, fat stores in children and adolescents but changes with age.29 Obesity was classified as a BMI of 25 kg/m² or higher or a BMI in the 95th percentile or higher.

Smoking, allergic rhinitis and atopy

Self-reported current smoking was defined as having smoked for ≥20 days in the past month before the survey. Allergic rhinitis was defined as a yes response to the question 'Did a doctor ever say that you had allergic rhinitis?' Atopy was defined as a yes response to the question 'Did a doctor ever say that you had atopy?'

Socio-demographic and socio-economic status information

The socio-demographic variables used were the adolescent’s grade level in school and gender; the SES was assessed using the family affluence scale (FAS). Grade level in school was considered as the proxy for age, with the 7th and 12th grades corresponding to ~12 and 17 years of age, respectively. The four questions of the FAS used to measure SES and their corresponding response categories were as follows: 'Does your family own a car?' 'no' (0), '1' (1), or '2' (2). 'Do you have your own bedroom?' 'no' (0) or 'yes' (1). 'How many times did you travel away on holidays during the past 12 months?' 'never' (0), 'once' (1), 'twice' (2), or '3 times or more' (3). 'How many computers does your family own?' 'none' (0), '1' (1), '2' (2), or '3 or more' (3).

The family affluence level (FAL) was calculated for each person on the basis of the respondent’s response to the 4 items and was assigned 1 of the 3 FAS scores, that is, low (score, 0–2), middle (score, 3–5) and high (score, 6–9).30 Since adolescents have little economic power, the SES of parent’s occupation has been most widely used as the proxy for adolescent SES. However, few adolescents knew or were willing to reveal such information, and a high percentage of nonresponse to the question about parental occupation was frequently noted. The FAS has several benefits because the questions in the FAS are easy for children and adolescents to answer. The FAS measure was validated in the Health Behavior in School-Aged Children Survey31 and showed a low percentage of missing responses and cross-national comparability.32

Statistical analysis

The statistical software SPSS version 17.0 was used in all the analyses to evaluate the complex sample survey. For statistical assessments, we took into consideration the complex sampling design of the KYRBWS. To investigate bivariate associations of asthma with sociodemographic and socioeconomic variables and covariates, the Rao–Scott chi-squared test, a design-adjusted version of the Pearson chi-square test, was conducted using a cross-tabulation analysis; this was performed using the statistical software SPSS Complex Sample. To assess associations between asthma and PA, multiple logistic regression methods were implemented using logistic regression analysis performed using the same statistical software. Adjustments were successively made for sociodemographic and socioeconomic variables and covariates, namely, gender, age and FAL (adjusted 1), and gender, age, FAL, allergic rhinitis, atopy, smoking and obesity (adjusted 2). A P = .05 was considered an indicator of statistical significance.
Results

Overall, 72,943 adolescents from the original sample were included in our analyses. The distribution of the subjects with asthma according to gender, grade level, FAL, allergic rhinitis, atopy, smoking and obesity based on the KYRBWS data is presented in Table 1. The adolescent boys were more likely to have current asthma, take medication for asthma, be unable to work because of asthma, and be absent from school because of asthma. Those with higher grade levels were less likely to have current asthma. Those with a high FAL were more likely to have current asthma and less likely to take medication for asthma, be unable to work because of asthma, and be absent from school because of asthma. In addition, those with allergic rhinitis and atopy were more likely to have current asthma, take medication for asthma, be unable to work because of asthma, and be absent from school because of asthma. Those who smoked were more likely to have current asthma, be unable to work because of asthma, and be absent from school because of asthma. Adolescents with obesity were more likely to have current asthma and less likely to take medication for asthma. Those who were never absent. On the other hand, those who were absent for 4 days or more per year were 26% [odds ratio (OR) 0.74; 95% CI 0.60–0.91] and 43% (OR 0.57; 95% CI 0.44–0.74), respectively, less likely to spend sedentary time of <3 h per day than those without current asthma. The associations between asthma severity and other PAs were insignificant.

Discussion

This study was based on the data of a representative national sample of Korean adolescents attending middle and high school in 2007. To our knowledge, the two important findings of this study are as follows. First, consistent with other studies, this study showed that gender, age, SES of the family and covariates, including allergic rhinitis, atopy, smoking and obesity, were related to the prevalence of current asthma and asthma severity among adolescents. Second, a significant association between current asthma and sedentary time was demonstrated in adjusted two models, adjusted for gender, age, FAL, allergic rhinitis, atopy, smoking and obesity.

Similar types of data have been collected by the Youth Risk Behavior Surveillance in the USA for children aged 9–12 years. Although a precise comparison of surveys was not possible, the results showed that significantly more students with current asthma than without current asthma were overweight and used a computer for ≥3 h per day. However, with regard to participation in adequate vigorous or moderate PA or strengthening exercise, the differences between the students with and without current asthma were insignificant.22 In a review of studies examining aerobic and anaerobic fitness among children and adolescents with asthma, Welsh et al.33 identified seven studies in which no differences existed between youths with and those without asthma and seven studies in which fitness levels among youths with asthma were lower than those

---

Table 1 Distribution of asthma according to gender, grade, family affluence level, allergic rhinitis, atopy, smoking, and obesity, using the KYRBWS 2007 data

<table>
<thead>
<tr>
<th>Gender</th>
<th>Current asthma (%)</th>
<th>Take medication for asthma (%)</th>
<th>Unable to work for asthma (%)</th>
<th>Absence for asthma (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>9.7</td>
<td>90.3</td>
<td>16.0</td>
<td>48.5</td>
</tr>
<tr>
<td>Female</td>
<td>7.2</td>
<td>92.8</td>
<td>8.7</td>
<td>53.3</td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7th</td>
<td>8.5</td>
<td>91.5</td>
<td>0.014*</td>
<td>12.4</td>
</tr>
<tr>
<td>8th</td>
<td>9.2</td>
<td>90.8</td>
<td>15.9</td>
<td>52.0</td>
</tr>
<tr>
<td>9th</td>
<td>9.0</td>
<td>91.0</td>
<td>13.2</td>
<td>51.1</td>
</tr>
<tr>
<td>10th</td>
<td>8.3</td>
<td>91.7</td>
<td>12.4</td>
<td>48.8</td>
</tr>
<tr>
<td>11th</td>
<td>8.5</td>
<td>91.5</td>
<td>10.9</td>
<td>49.2</td>
</tr>
<tr>
<td>12th</td>
<td>7.7</td>
<td>92.3</td>
<td>13.2</td>
<td>42.3</td>
</tr>
<tr>
<td>FAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>8.7</td>
<td>91.3</td>
<td>0.001***</td>
<td>29.0</td>
</tr>
<tr>
<td>middle</td>
<td>8.1</td>
<td>91.9</td>
<td>10.9</td>
<td>51.3</td>
</tr>
<tr>
<td>high</td>
<td>9.2</td>
<td>90.8</td>
<td>13.7</td>
<td>52.8</td>
</tr>
<tr>
<td>Allergic rhinitis</td>
<td>16.7</td>
<td>83.3</td>
<td>15.4</td>
<td>54.2</td>
</tr>
<tr>
<td>no</td>
<td>5.9</td>
<td>94.1</td>
<td>11.0</td>
<td>46.9</td>
</tr>
<tr>
<td>Atopy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>15.3</td>
<td>84.7</td>
<td>17.6</td>
<td>47.8</td>
</tr>
<tr>
<td>no</td>
<td>7.1</td>
<td>92.9</td>
<td>11.1</td>
<td>51.6</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>11.6</td>
<td>88.4</td>
<td>12.9</td>
<td>41.5</td>
</tr>
<tr>
<td>no</td>
<td>9.1</td>
<td>90.9</td>
<td>13.3</td>
<td>48.6</td>
</tr>
<tr>
<td>Obesity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>9.8</td>
<td>90.2</td>
<td>12.7</td>
<td>50.4</td>
</tr>
<tr>
<td>no</td>
<td>8.2</td>
<td>91.8</td>
<td>12.7</td>
<td>51.0</td>
</tr>
</tbody>
</table>

*P<0.05; **P<0.01; ***P<0.001, tested by the Rao–Scott chi-squared test considering complex sampling design.
among youths without asthma. Some studies suggested that child and parental beliefs, more than asthma status or severity, may determine PA and aerobic fitness among students with asthma.34,35

These controversial results could be attributed to differences in methodologies between the previous studies and to the inherent difficulty in ascertaining with cross-sectional data whether sedentary time increases asthma prevalence or whether patients with asthma avoid PA. Therefore, it is still controversial and further investigation is needed.

Although it is still controversial, schools should be encouraged to help students with asthma participate in PA. For this purpose, health-care providers and families should coordinate with schools and help the school staff identify students with asthma and ensure that their prescribed medications are available during periods of PA. Furthermore, schools should encourage students to prepare for PA, such as the use of their prescribed pre-exercise treatment and performing warm-up exercises before vigorous PA. Moreover, schools should modify the PA when symptoms are present or when environmental conditions are a concern.

When asthma is appropriately managed, participation in PA is not only considered safe for students with asthma but is also strongly recommended.36,37 In a review of effects of physical conditioning in children and adolescents with asthma, many studies showed improved aerobic fitness after training36 In the same review, some studies found a reduced severity in exercise-induced asthma, although most found no changes in the occurrence or the degree of exercise-induced asthma, suggesting no increase in the risk of asthma attacks or episodes because of increased PA. Physical fitness and maintenance of a healthy body weight may actually reduce asthma symptoms and help control the disease.36–38

This study has limitations. First, these data apply only to adolescents who attended school in Korea during 2007. Secondly, because the data were collected by a self-reported questionnaire, responses may be subject to recall and social desirability bias. Respondents may tend to overestimate socially desirable behaviours and underestimate negative behaviours even though the use of an anonymous online survey method might considerably reduce this possibility. Third, this study was conducted using the online method; therefore, the height and the weight of the adolescents were not measured directly but were self-recorded. It is possible that the level of obesity that was measured was relatively low because adolescents have a tendency to grow in height and lose weight.39 Furthermore, the meaning of vigorous activity might differ between students and, in particular, between students with and without asthma. Fourth, the data in this study were obtained from a cross-sectional survey; thus, this study did not examine cause and effect but interrelationship.

**Conclusion**

In conclusion, no significant differences with regard to participation in adequate vigorous or moderate PA, strengthening exercise or physical education classes were found between adolescent students with and without current asthma. In addition, no significant differences among all PAs and asthma severity (taking medication, inability to work and absence from school) were observed. Our results show that increased sedentary time might influence asthma prevalence (adjusted 1, Table 2); however, students with current asthma had significantly less sedentary time but still had asthma (adjusted 2, Table 2).
Acknowledgements
This work was supported by a special research grant from Seoul Women’s University (2012).

Conflicts of interest: None declared.

Key points
- Unlike some other risk factors for developing or exacerbating asthma, PA or sedentary time has the advantage that it can be modified.
- Physically active youths are more likely to have stronger bones, normal weight and more health benefits. Health-care providers are trusted sources from whom families can obtain information about the benefits of achieving and maintaining an appropriate weight and engaging in adequate PA. Likewise, school and community policies and programmes can play an important role in asthma management, including promotion of the maintenance of an appropriate weight and continued PA.
- Although these analyses did not show any association between asthma and PA, current efforts by all youths to engage in the recommended amounts of PA should be encouraged.

References
4 Braman SS. The global burden of asthma. Chest 2006;130:45–125.
38 Tanitsira KG, Weiss ST. Complex interactions in complex traits: obesity and asthma. Thorax 2001;56:64–73.